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PARASITE COLONIZATIONS AGAINST *CRIOCERIS ASPARAGI* (L.) AND *C. DUODECIMPUNCTATA* (L.) (COLEOPTERA: CHRYSOMELIDAE) IN NORTH AMERICA FROM 1983 TO 1988

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Abstract.—Three species of parasites were colonized against *Crioceris asparagi.* Of these *Lemophagus crioceritor* Aubert (Hymenoptera: Ichneumonidae) is probably established in Canada. Two species of parasites were released against *C. duodecimpunctata* but none was recovered.

Key Words: Insecta, asparagus, biological control, parasite, *Lemophagus, Tetrastichus, Meigenia, Diaparsis, Paralispe, Mesochorus*

Two species of chrysomelid beetles, the asparagus beetle (AB), *Crioceris asparagi* (L.), and the spotted asparagus beetle (SAB), *C. duodecimpunctata* (L.), are serious pests of asparagus culture in North America. Both species are exotic; their origin is believed to be Europe. There are 83,000 acres of commercial asparagus in the United States with an annual value in excess of $82 million. The acreage is spread over 12 states with the highest production in California, Washington, Oregon, Michigan, and Illinois. *Crioceris* species are serious pests of asparagus in all states except California. In three states, Washington, Michigan, and Illinois, the annual loss to beetle feeding damage, resultant market culling, and the cost of partially effective chemicals used in an attempt to control the beetles is between $1.4 and $1.6 million. In New Jersey, there are generally three spray applications per year at a total cost of about $200,000. Even so the beetles remain a problem.

The USDA Agricultural Research Service conducted a biological control program against these beetles in North America in the 1980s. This is a summary of the project.

Materials and Methods

To obtain parasites of the beetles, large numbers of late instar *C. asparagi* larvae were collected from asparagus fields in France, and then held in screen bottom cages at the European Parasite Laboratory, then at Sevres, at ambient room conditions. Bouquets of asparagus ferns were supplied as food. Mature larvae dropped through the screen bottom of the cage and pupated in a mixture of moist sand and vermiculite. To obtain parasites of SAB, large numbers of asparagus berries infested with SAB larvae were collected and held under the same con-

ditions. Mature larvae of this species emerged from the berries, dropped to the substrate, and burrowed into it to pupate.

Adult and pupal parasites which emerged were sent to the Beneficial Insects Research Laboratory, Newark, Del. Pupae were held in quarantine until emergence of the adult parasites. After clearance from quarantine, parasite species were divided among project researchers directly involved in the project in Delaware, Maryland, and Quebec, Canada, and cooperators in Delaware, Maine, Maryland, Missouri, New Jersey, Virginia, and Washington for study and colonization.

Field recovery sampling of the colonization sites consisted of weekly collections of up to several hundred mature larvae, depending on the abundance of the beetle larvae. AB larvae were held in small cages in the laboratory with bouquets of asparagus ferns for food. Since SAB larvae develop in asparagus berries, 473 ml (1 pint) of fully formed berries, green or red in color, were collected weekly for recoveries of the introduced parasites.

Results and Discussion

European collections: A total of 145,560 *C. asparagi* larvae and 136,560 *C. duodecimpunctata* larvae were collected in France. From this material, five primary parasites were recovered. They were *Diaparsis truncatus* (Gravenhorst) (Hymenoptera: Ichneumonidae), *Lemophagus crioceritor* Aubert (Hymenoptera: Ichneumonidae), *Meigenia mutabilis* (Fallen) (Diptera: Tachinidae), *Tetrastichus asparagi* Crawford and *T. crioceridis* Graham (Hymenoptera: Eulophidae). Of these, two species were new to science: *Lemophagus crioceritor* was described by Aubert (1986) and *Tetrastichus crioceridis* by Graham (1983). The following is a summary of the parasite species composition and abundance from the total host collections.

AB:	*Tetrastichus asparagi*	10.3%
	Meigenia mutabilis	16.1%
	Lemophagus crioceritor	7.9%
	Total	34.3%

The hyperparasite, *Mesochorus testaceus* Gravenhorst (Hymenoptera: Ichneumonidae), was recovered from 32.1% of the host insects containing *L. crioceritor.*

SAB:	*Diaparsis truncatus*	20.0%
	Tetrastichus crioceridis	17.8%
	Total	37.8%

North American colonizations: The total numbers of parasites colonized in the United States and Canada were 11,236 (50.2% ♀) *D. truncatus*; 4481 (49.8% ♀) *Lemophagus crioceritor* (1600 additional pupae were used for laboratory studies); 8381 (56.8% ♀) *M. mutabilis*; 34,731 (96.5% ♀) *T. asparagi*; and 86,018 (73.0% ♀) *T. crioceridis.*

Recovery of *L. crioceritor:* A total of 166 *L. crioceritor* was released at a field adjacent to the Beneficial Insects Research Laboratory, Newark, Del. in 1984 and 1985. Recovery attempts were made at this site from 1986 to 1989 and a total of 1566 AB larvae were collected. Of these, 65.0% produced adult beetles and 2.1% produced parasites of three species. A single specimen of *L. crioceritor* was recovered in 1986, three specimens in 1987, no specimens in 1988 or 1989, although a single live individual was observed on the asparagus plants in July 1988.

In Maryland only one adult *L. crioceritor* was ever recovered from any of the colonization fields. That was from the Beltsville Agricultural Research Center in 1986, the year after the initial colonizations.

Colonizations were also made by RMH and JJD at 25 other sites in Delaware, Maryland, and New Jersey. The sites were commercial fields subjected to regular insecticidal treatments. AB larvae were collected from 19 of these fields for the next 2 years, but *L. crioceritor* was only recovered in the year of colonization.

At L'Assomption, Quebec, a total of 312 adults of *L. crioceritor* was colonized in 1985 and 1986. In 1987 parasitization was 8.9% (n = 74). An administrative change in re-

search objectives prevented recovery attempts in later years.

Harmer et al. (1990), cooperators at the University of Guelph, Ontario, released *L. crioceritor* in 1987. They found a rate of parasitism of 15.7% for the first generation and 24.8% for the second generation in 1989, which suggests the parasite is probably established.

The probable establishment of *L. crioceritor* in Canada and its probable failure to establish, at least in recoverable numbers, in the Middle Atlantic states suggest that the parasite is favored by cooler northern latitudes. A similar situation was noted in France. The overall percentage parasitization in the fields studied in France averaged 7.9%. However, in the most northern collection sites, the departments of Loiret and Loir-et-Cher, parasitization was 8.6%. In the most southern collection area, the department of Drome, the parasitization was only 0.6%.

Recovery of other parasite species: The gregarious larval parasite, *T. asparagi,* was recovered from AB collected from 1986–1989. However, the overall parasitization was extremely low. Only 0.5% (n = 7) of the hosts from which live forms emerged were parasitized by the eulophid and 31 individuals emerged at the Beneficial Insects Research Laboratory. Although *T. asparagi* was recorded in North America as early as 1863 (Clausen 1978), specimens were colonized to increase the genetic diversity of the parasite and possibly increase its effectiveness in North America. FG found that 10.3% of the hosts were parasitized by *T. asparagi* in France.

At L'Assomption, Quebec, the average maximum parasitism by *T. asparagi* was 39.1% in the first generation and 49.2% in the second generation for 1980–1987. These figures are very much higher than those found in Delaware. This suggests the parasite has definite climatic preferences.

A native solitary parasite, *Paralispe infernalis* (Townsend) (Diptera: Tachinidae), was recovered from many samples in Maryland and Delaware, but it produced only 2.1% parasitization (n = 22) at the Beneficial Insects Research Laboratory and apparently had no controlling impact on the populations of the host.

Since no specimens of parasites released against SAB were recovered and only one species, *L. crioceritor,* is probably established against AB, the USDA has discontinued the introduction program. However, there is still the possibility that *Lemophagus* will continue to increase in the northern areas of distribution of *C. asparagi* in North America.

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